# INVENTORY AND STAND SELECTION

## INTRODUCTION

Old-growth forests are an important component of biological diversity. Old-growth stands are characterized by an increasing variety in sizes and species composition of trees, and more diversity of functions and interactions as compared with earlier successional stages. A complex, multi-storied structure and a mosaic of both early and late successional stages often are important attributes (Bormann and Likens 1979). Old-growth forests are not the same as successional climax (habitat type), often being dominated by seral tree species.

The greater vertical and horizontal diversity found within an old-growth stand allows for niche specialization by wildlife. Although the individual wildlife species occurring may not be unique to old-growth stands, the assemblage of wildlife species and the complexity of interactions between them are different than in earlier successional stages.

## OLD-GROWTH FORESTS: CONDITIONS IN THE NORTHERN ROCKIES

The Northern Rocky Mountains exhibit very diverse vegetation patterns. In addition to wide gradients in climate and elevation, wildfire has played a major role in the evolution of forest ecosystems in the northern Rockies (Habeck 1987). At the time of European settlement, fire-generated or fire-perpetuated forest types dominated much of the region.

Northern Idaho and northwestern Montana, which experience an inland maritime climate, support near-climax old-growth forests dominated by western redcedar and western hemlock, as well as subclimax old-growth stands dominated by western larch and western white pine. These sites historically burned infrequently, at 100 to 200-year intervals, often by high-intensity stand replacing fires (Habeck 1985).

In west-central Montana, old-growth forests at lower elevations were typically maintained as an open-canopied savanna by frequent (5 to 20-year interval), low intensity ground fires (Arno 1980). These stands were dominated by western larch and ponderosa pine, or by Douglas-fir on moister sites. Recent fire suppression has favored shade-tolerant tree species such as Douglas-fir. At higher elevations, old-growth forests are dominated by true firs and burn less frequently.

In central and eastern Montana, lodgepole pine dominates large acreages. Lodgepole pine stands typically experience frequent, stand-replacing disturbances from fire or insect outbreaks. Along the eastern ecotone between forest and grassland, ponderosa pine and limber pine stands experienced frequent low-intensity fires (Habeck 1988).

## DEFINITIONS OF OLD-GROWTH

Attributes of old-growth stands include large-diameter overstory trees, presence of large standing dead and defective trees, presence of down logs, development of a deep duff layer, and formation of canopy gaps and several canopy layers. Several of these attributes may be less apparent in types experiencing frequent fire.

Long periods of time are required to develop old-growth conditions within a stand. However, stand age may not accurately predict the onset of old-growth conditions, because tree species, site conditions, fire or other disturbance, variations in weather, and other factors interact to affect the rate of succession within a stand.

Structural attributes have generally been used as descriptors of old-growth stands. Pfister (1987) attempted to identify existing old-growth stands on the Nez Perce and Kootenai National Forests, using overstory tree size, density of snags, density of down material, canopy closure, and canopy layering. Some of the attributes, particularly snags and down logs, were inadequately sampled. Using stand exam data, Pfister found that few stands met all of the pre-determined criteria for old-growth stands.

The national definition developed by the USDA Forest Service describes old growth conceptually, in terms of plant succession and general characteristics. Ecological classifications are to be developed to define the old-growth community type(s) for each major forest type (or forest type group). Definitions for old-growth communities will be based on vegetation structural characteristics which are easily measured.

## OLD-GROWTH INVENTORY

**Forest-Wide Inventory.** Forest-wide estimates are needed of the relative abundance, patch sizes, and spatial distribution of old-growth habitats by forest type. As a first approximation, *candidate* old-growth habitats should be identified, by stand or groups of stands.

Timber stands are delineated on the basis of predominant overstory species, tree size, and tree density. Contiguous old-growth habitat may be composed of more than one stand.

Data sources for identification of candidate stands could include aerial photographs, satellite imagery, timber stand exam data, Ecodata plot data, and other inventories. Detailed information, particularly on dead trees and down logs, may not be available for each stand. For this reason, additional field analysis of candidate stands may be needed.

Candidate old-growth habitat maps should be updated periodically, to reflect actual old-growth habitat delineations as site-specific inventory information becomes available.

To develop an ecological classification for old-growth community types, data on dominant and indicator species must be collected. The Ocular Macroplot or the Cover Microplot sampling methods (FSH 2090.11) would be suitable for this purpose. The optional Density sampling method can be used to estimate the density of components such as snags and down woody material.

**Site-specific Stand Analysis.** Stand exam and Ecodata plot sampling methods are recommended to describe vegetation composition, tree characteristics, and structure within a stand. Additional sample plots are needed for components that occur in low densities, such as snags and down woody material.

A general rating of the ability of a given stand to provide old-growth habitat conditions can be made. If the old-growth criteria are used collectively as an "in/out" screen, some stands may be excluded which do in fact have value. Thus, a relative rating system should be used.

Old growth "Scorecards" have been used successfully in various areas. Points are scored for each parameter (such as overstory tree size, number of trees per acre, canopy cover, canopy structure, density of snags and down logs, and decadence) and summed for the stand.

Example scorecards, which are based on judgement rather than data, are shown in Exhibit 1. Scorecards should be refined to reflect local habitat types and conditions. To interpret the meaning of the scoring, comparisons could be made with reference stands (those sampled to develop old-growth community classification).

## EXHIBIT 1. EXAMPLE SCORECARD TO ASSESS OLD-GROWTH HABITAT QUALITY

*Estimated Parameters - Should be Refined to Reflect Field Data*

**West-side Mixed Conifer**

**First rate individual stands:**

| | 0 | 1 | 2 | 3 | Weight | Sum |
|---|---|---|---|---|---|---|
| Trees per Acre >20" DBH | 0-8 | 9-16 | 17-24 | 25+ | | |
| Trees per Acre >30" DBH | 0 | 1-2 | 3-4 | 5+ | 2 | |
| Canopy Cover, Polesize and Larger Trees (%) | <40 | 40-69 | 90-100 | 70-89 | 1 | |
| Snags per Acre >20" DBH >15 Ft. Tall | <0.5 | 0.6-1.9 | 2.0-2.9 | 3.0+ | 2 | |
| Down Logs Tons per Acre >10" diameter | <20 | 20-29 | 30-39 | 40+ | 1 | |
| Canopy Layering | | one | two | three | | |
| Decadence (% overstory w/ conks, spike or broken top) | none | 1-10% | 11-25% | >25% | 2 | |
| | | | | | **Stand Score:** | |

**Then rate old-growth patch (may include several adjacent stands):**

| | 0 | 1 | 2 | 3 | Weight | Sum |
|---|---|---|---|---|---|---|
| Insularity (% of boundary against seedling or sapling stands) | 76-100 | 51-75 | 26-50 | <25% | | |
| Contiguous Acres | <50 | 50-80 | 80-125 | >125 | 2 | |
| Patch Shape * | A | B | C | D | 1 | |
| | | | | | **Patch Score:** | |

*Patch Shape
A = Linear, narrow
B = Linear, wider than 200 ft.
C = Irregular
D = Circular

**East-side Mixed Conifer**

**First rate individual stands:**

| | Points 0 | 1 | 2 | 3 | Weight | Sum |
|---|---|---|---|---|---|---|
| Trees per Acre >15" DBH | 0-5 | 6-10 | 11-20 | 20+ | 1 | |
| Trees per Acre >20" DBH | 0 | 1-2 | 3-4 | 5+ | 2 | |
| Canopy Cover, Polesize and Larger Trees (%) | <30 | 30-49 | 50-69 | >70 | 1 | |
| Snags per Acre >15" DBH >15 Ft. Tall | <0.5 | 0.5-1.0 | 1.1-2.0 | >2.0 | 2 | |
| Down Logs Tons per Acre >10" diameter | <10 | 10-20 | 21-30 | >30 | | |
| Canopy Layering | | one | two | three | 1 | |
| Decadence (% overstory w/ conks, spike or broken top) | none | 1-10% | 11-25% | >25% | 2 | |
| | | | | | **Stand Score:** | |

**Then rate old-growth patch (may include several adjacent stands):**

| | 0 | 1 | 2 | 3 | Weight | Sum |
|---|---|---|---|---|---|---|
| Insularity (% of boundary against seedling or sapling stands) | 76-100 | 51-75 | 26-50 | <25% | 1 | |
| Contiguous Acres | <25 | 25-50 | 51-80 | >125 | 2 | |
| Patch Shape * | A | B | C | D | 1 | |
| | | | | | **Patch Score:** | |

*Patch Shape — A = Linear, narrow; B = Linear, wider than 200 ft.; C = Irregular; D = Circular

## WILDLIFE SPECIES ASSOCIATED WITH OLD-GROWTH HABITATS

Meslow and Wight (1975) found that 69 percent of the birds occurring in Douglas-fir forest types of the Pacific Northwest used old-growth stands. Three species were listed as nesting primarily within old-growth forests: spotted owl, northern goshawk, and Vaux's swift. Bull (1978) identified six species which are primarily associated with old-growth forests in Oregon: great gray owl, barred owl, flammulated owl, white-headed woodpecker, northern three-toed woodpecker, and Townsend's warbler. The marten is associated with mature and old-growth spruce-fir forests in Idaho (Koehler and Hornocker 1977).

In northwestern Montana, McClelland (1977) described a general trend of increased species richness in cavity-nesting birds from young to old-growth stands of larch and Douglas-fir. Old growth was particularly important in providing an adequate number of suitable nesting trees for cavity-nesters. He also noted the association of open-nesters such as the pine grosbeak, Townsend's warbler, varied thrush, black-headed grosbeak, and goshawk with old-growth forests, as well as its value as big game thermal cover.

Based on a literature review, about 40 percent of the 373 wildlife species occuring in the Northern Region were thought to use old-growth forest for feeding and/or reproduction (Harger 1978). Of these, 33 species were thought to be closely associated with old-growth habitats (Table 1).

The following describes the importance to wildlife of various components of old-growth habitats.

**Overstory Trees.** Large trees are needed to provide suitable nesting sites for large birds. Bark crevices in older trees provide important foraging sites. Large-canopied trees can modify microclimate by providing shade, capturing moisture, and moderating winds.

**Dead and Defective Trees.** Dead trees (snags) and defective trees (partially dead, spike top, broken top) provide nesting and roosting sites for cavity-users. Snags host invertebrates which are an important food source for woodpeckers.

**Down Woody Material.** Downfall supports insects and other invertebrates, provides habitat for fungi and saprophytic plants, provides cover and den sites for wildlife, and creates debris dams in streams. Dead woody material holds moisture and contributes to nutrient cycling. In areas with high frequency of fire, this component will be less abundant.

**Tree Canopy.** A relatively closed canopy, often with two or more layers, creates a more moderate microclimate. Vertical diversity provides a variety of substrates for feeding or nesting, and supports development of forest components such as arboreal lichens.

**Decadence.** Presence of heart rot, mistletoe, dead or broken tree tops, diseased trees, and saprophytic plants create a variety of microsites and food sources for wildlife.

## MANAGEMENT INDICATOR SPECIES

The National Forest Management Act and its implementing regulations require that fish and wildlife habitats be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. In order to estimate the effects of each Forest Plan alternative on fish and wildlife populations, Management Indicator Species (MIS) are to be selected.

Table 1. Species in the Northern Region (north Idaho, Montana, North Dakota, and South Dakota) thought to prefer old-growth components for breeding or feeding (from Harger 1978).

| WILDLIFE SPECIES | STRUCTURAL STAGES Breed | Feed | OPTIMUM COVER TYPE |
|---|---|---|---|
| Great Blue Heron | 5-6 | 1 | ASP, COT |
| Northern Goshawk | 5-6 | 3-6 | ASP, DF, PP, LPP |
| Great Gray Owl | 6 | 1 | LPP, SAF, SP |
| Flammulated Owl | 5-6 | 1-2 | PP, DF, GF, LPP |
| Pygmy Owl | 5-6 | 1-6 | PP, DF, GF, WL |
| Saw-whet Owl | 5-6 | 1-6 | PP, DF, GF, LPP, SAF, SP |
| Boreal Owl | 5-6 | 1-6 | PP, ASP, SP, SAF, DF |
| Barred Owl | 5-6 | 3-6 | COT, DF, GF |
| Vaux's Swift | 5-6 | 1-6 | ASP, COT, DF, WRC |
| White-headed Woodpecker | 4-6 | 4-6 | PP, WWP |
| Pileated Woodpecker | 4-6 | 3-6 | COT, PP, WL, GF |
| Three-Toed Woodpecker | 4-6 | 3-6 | SAF, WBP |
| Black-backed Woodpecker | 4-6 | 3-6 | PP, DF, WWP |
| Red-naped Sapsucker | 4-6 | 1-6 | BGA, COT |
| Williamson's Sapsucker | 4-6 | 2-6 | PP, WL, GF, SAF, SP |
| White-breasted Nuthatch | 4-6 | 3-6 | PP, DF |
| Red-breasted Nuthatch | 4-6 | 3-6 | PP, ASP, LPP, SAF, SP |
| Pygmy Nuthatch | 4-6 | 3-6 | PP, DF |
| Brown Creeper | 4-6 | 3-6 | DF, LPP, SP, SAF |
| Great Crested Flycatcher | 4-6 | 2-4 | BGA, COT |
| Hermit Thrush | 5-6 | 2-6 | GF, WH, WRC, SAF, SP |
| Varied Thrush | 5-6 | 2-6 | WH, WRC, SP |
| Townsend's Warbler | 4-6 | 2-6 | ASP, COT, PP, DF |
| Silver-haired Bat | 3-6 | 1-3 | PP, DF, WRC, SP |
| Long-eared Bat | 4-6 | 1-6 | PP, DF, GF |
| Long-legged Myotis | 4-6 | 1-6 | LPP, SAF, SP |
| California Myotis | 4-6 | 1-6 | BGA, COT, PP, JPU |
| Fisher | 5-6 | 3-6 | ASP, COT, PP, DF, WWP |
| Marten | 5-6 | 2-6 | LPP, SAF, SP, WRC |
| Wolverine | 3-6 | 1-6 | SAF, WBP |
| Woodland Caribou | 5-6 | 5-6 | SAF, SP, WH, WBP |
| Boreal Red-back Vole | 4-6 | 4-6 | SAF |
| Northern Flying Squirrel | 5-6 | 5-6 | ASP, COT, DF, WWP, SAF |

*Structural Stages:* 1=Grass/Forb, 2=Shrub/Seedling, 3=Pole Trees, 4=Young Trees, 5=Mature Trees, 6=Old-Growth

*Cover Types*: ASP=Aspen, BGA=Birch/Green Ash, COT=Cottonwood, DF=Douglas-fir, GF=Grand Fir, JPU=Juniper, LPP=Lodgepole Pine, LP=Limber Pine, PP=Ponderosa Pine, SAF=Subalpine Fir, SP=Spruce, WH=Western Hemlock, WL=Western Larch, WRC=Western Redcedar, WWP=Western White Pine, WBP=Whitebark Pine

Several categories of species are to be represented where appropriate: Endangered and threatened plant and animal species; species with special habitat needs that may be influenced significantly by planned management programs; species commonly hunted, fished or trapped; non-game species of special interest; and plant or animal species selected because their population changes are believed to indicate the effects of management activities on other species of selected major biological communities (36 CFR 219.19). The first four categories of MIS include "featured species", wherein management activities are directed to providing specific habitat components to meet management objectives for the individual species. The latter category is intended to include ecological indicators, which are selected to represent a larger community of species.

An ecological indicator will ensure the welfare of only those species whose niches are entirely included within its habitat niche and geographic range. To be effective, then, an ecological indicator should have a large home range and be closely associated with a specific habitat.

The goshawk, pileated woodpecker, and marten were identified as MIS by most Forests in the Northern Region to be used as ecological indicators for old-growth components or old-growth habitats. Each of these species have habitat requirements related to stand structure or components which are more likely to be found in old-growth habitats. Their population densities generally are higher in old-growth than in younger stands. In a California study, both marten and pileated woodpecker were found to be sensitive to habitat fragmentation (Rosenberg and Raphael 1986). Each of these species utilize a relatively large home range, which is thought to include the home ranges of other old-growth-associated species.

The habitat requirements of pileated woodpecker, goshawk, and marten, and models for assessing habitat suitability for each are detailed in subsequent sections. Although Schroeder (1987) identified several problems in HSI modeling, they are the most expedient method for evaluating impacts of habitat change.

The requirements of these species in terms of the size and spacing of habitat patches can be used to determine the distribution of old-growth habitats across the landscape.

## OLD-GROWTH STAND SELECTION

**Landscape Ecology Theory.** Forman and Godron (1981) defined landscape patches as communities surrounded by a matrix with a dissimilar community structure or composition. They hypothesized that species diversity within a patch is a function of habitat diversity, disturbance, area, age, surrounding heterogeneity, isolation, and boundary discreteness.

Old-growth habitats offer comparatively high within-stand structural diversity. As forest management progresses through time, old-growth forests will be represented as remnant patches embedded in a younger-aged matrix.

Patch size correlates strongly with the numbers of species and individuals that can be supported and with rates of extinction and recolonization (May 1975, Simberloff and Aberle 1982). Patch size is particularly significant for large, wide-ranging species (Noss and Harris 1986). As acreage decreases, habitat patches become unsuitable for wildlife species with large home ranges. Of 48 old-growth-associated species occurring in the Northern Region, about 60 percent are thought to require stands larger than 80 acres (Harger 1978).

Patch size is modified by its shape due to edge effect. Changes in temperature, humidity, light, and wind, which influence plant species composition, can occur in a band along the ecotone (edge) (Greene 1988). In Douglas-fir old-growth forest, a circular-shaped stand smaller than 25 acres is effectively all "edge" (influenced by the ecotone); within a stand of 80 acres, half of the patch provides "interior" conditions (Lemkuhl and Ruggerio in prep.). In northern California, Rosenberg and Raphael (1986) found that old-growth Douglas-fir stands of less than 50 acres tended to lack the full complement of vertebrate wildlife, and suggested that isolated stands should exceed 125 acres in size to be effective. Wilcove et al. (1986) estimated that habitat islands should exceed 250 acres to provide for birds inhabiting forest interior.

The abruptness of the edge, or edge contrast, affects stand insularity. Edges between similar cover types and successional stages cause less isolation than do edges between very dissimilar stands. A patch totally surrounded by dissimilar habitat becomes more similar to a true island, with less movement of species between patch and matrix (Forman and Godron 1981).

**Selection of Stands to Manage for Old-Growth Conditions.** The recommended scale for initial analysis of the quality and distribution of existing old-growth habitats is the watershed scale (typically about 10,000 acres in size). Individual stands or groups of contiguous stands can be evaluated using a scorecard method. The habitat requirements and dispersal capabilities of old-growth Management Indicator Species should be used to determine the size, shape and spacing of old-growth patches across the forest landscape.

If a particular analysis unit does not contain existing stands of high quality, large enough size, or sufficient overall acreage, the best available (nearest to old-growth condition) stands should be selected. Alternatively, old-growth stands in adjacent watersheds could be selected, provided the spacing of old-growth patches does not exceed the mobility of the MIS.

Roads are generally undesirable within an old-growth habitat patch. The road corridor fragments the habitat by creating edge, and access may result in loss of snags to woodcutting.

Landres et al. (1988) point out that selecting old-growth stands based on within-patch habitat conditions required by the MIS, and then predicting or monitoring habitat conditions for those MIS, is circular reasoning. Because old-growth-associated MIS are intended to represent a community of wildlife species, stand selection and management should not be directed only towards providing the minimum characteristics required by the individual species. Management objectives and actions in the selected old-growth patches should be directed towards protecting or enhancing the integrity and longevity of old-growth conditions.

In devising a conservation strategy, Forman and Godron (1981:738) emphasize the importance of recognizing that "no patch stands alone", but is influenced by surrounding patches. Harris (1984) recommended surrounding old-growth habitat islands with a long-rotation management area, and interconnecting these with riparian corridors and other linkages. Similarly, Noss and Harris (1986) suggest that a regional landscape level be used, wherein high-quality nodes, such as an old-growth patch, would be integrated within interconnected "multiple-use modules", where management activities are scheduled to maintain the integrity of the nodes.

Natural disturbance regimes such as fire often occur on a spatial scale larger than a landscape patch (Urban et al. 1987). Providing for well-distributed habitat patches with interconnections between patches thus are necessary to maintain species diversity over the long term.

# Pileated Woodpecker Habitat Relationships

William C. Aney and B. Riley McClelland

Revised by Nancy Warren, Karen Wilson, Mike Hillis, Bob Summerfield,
Carl Frounfelker, Tom Wittinger, and Wally Murphy

## INTRODUCTION

The pileated woodpecker requires tall, large-diameter dead or live defective trees within forest stands for nesting. It is particularly characteristic of old-growth stands of ponderosa pine, western larch, and black cottonwood stands.

Most of the Forests in the Northern Region have selected the pileated woodpecker as a Management Indicator Species for old-growth habitats. The following describes habitat requirements of the pileated woodpecker, a model to evaluate habitat suitability, and recommended methods for inventory and monitoring of habitats and populations.

## ECOLOGY OF THE PILEATED WOODPECKER

**Distribution.** The pileated woodpecker (*Dryocopus pileatus*) is a year-round resident of forested areas in the northern Rockies. This large woodpecker is absent from the central and southern Rockies (Bent 1964), probably due to the absence of dense highly productive forests in those regions (Bock and Lepthien 1975).

**Reproduction.** Courtship usually begins in mid-March. Both drumming and vocalizations are used by the male to attract a mate. Pileateds regularly begin breeding as one-year olds, and virtually all birds breed every year (Bull 1987).

One or more new cavities are excavated during courtship each year, within the heartwood of a tree. The distance between successive nests used by the same pair averaged 0.3 mile (0 - 1 mile) in Oregon (Bull 1987).

Clutch size is typically four. The incubation period, usually occurring in May, is about 18 days. The nestlings fledge about one month after hatching. Usually 2-3 young fledge from a nest.

Birds that were banded as nestlings and later nested withing the same study area in Oregon (Bull 1987) dispersed an average of two miles (0 - 5.2 miles).

**Nesting Habitat.** Typical pileated nest stand conditions can best be described as old-growth stands with a decadent overstory of western larch, ponderosa pine, black cottonwood, or aspen. Stands of 50 to 100 contiguous acres, generally below 5000 feet in elevation, with basal areas of 100-125 square feet per acre and a relatively closed canopy, were used for nesting (McClelland 1977, 1979a, Bull 1980). The grand fir cover type was preferred in Oregon and western larch/Douglas-fir cover types are preferred in Montana (Bull 1987, McClelland et al. 1979).

Nests in the northern Rocky Mountains most commonly occur in dead ponderosa pine, dead black cottonwood, or live or dead western larch trees. Nest trees average nearly 30 inches in diameter, and are more than 91 feet tall in Montana (Aney and McClelland 1985). Minimum nest tree diameter is 20 inches dbh. Nest cavities usually are located more than 30 feet above the ground, at a level within the canopy of the surrounding forest (McClelland 1979a, Bull 1980).

Heart rot appears to be an important feature of suitable nest trees. Decay fungi (*Larici-fomes laracis* or *Phellinus pini*) enter the heartwood of living or dead larch trees through a broken top, fire scar, or other wound; decay gradually softens the heart-wood while leaving a shell of sound sap-wood. Conner et al. (1976), McClelland (1977, 1979a), Mannan et al. (1980), and Harris (1983) all reported a high incidence of broken tops in nest trees.

Pileated woodpeckers are able to excavate cavities in sound wood, however. Bull (1975, 1980) reported that the majority of nest trees in her northeastern Oregon study area, where ponderosa pine was the most common nest tree, showed no evidence of decay at the nest site. This apparently is related to characteristics of the dominant nest tree species of the two regions. Ponderosa pine was the most common nest tree in northeastern Oregon; western larch was predominant in the Montana study. Sound ponderosa pine, with a specific gravity of about 0.37 g/ml, is considerably softer than sound western larch (specific gravity of 0.48-0.52 g/ml). Decayed western larch heartwood, however, is softer than sound pine wood (0.27 g/ml) (McClelland 1977, Harris 1983).

In the Northern Region, either live or dead larch trees can be suitable nest trees, if heart rot is present. Ponderosa pine trees need not have decay at the nest site, but the excavated portion of the bole must be dead. Nest excavation in black cottonwood occurs almost always in dead portions of the bole, but the presence of heart rot is not essential (McClelland 1977). Aspen can provide suitable nest sites if trees are large enough.

**Food Habits.** Pileated woodpeckers feed principally on carpenter ants (*Camponotus herculaneus* and *C. pennsylvanicus* , exca-vating deep into ant colonies in dead and decaying wood (Sutton 1930, Bent 1964, Hoyt 1957, McClelland 1977, Bull 1980, Miller and Miller 1980). Beal (1911) examined the stomach of one pileated woodpecker and found the remains of more than 2600 ants. Estimates of the proportion of ants in the diet range from 40-60% (Koehler 1981) to 95% (Bull 1987).

Other insects reported in the diet include termites (Isoptera) and beetles (Coleoptera), which are obtained by bark gleaning, scaling, or excavating. In winter, when few insects are available on the boles of trees, pileateds feed principally by excavating.

Fruits and berries form a secondary compo-nent of the diet of pileated woodpeckers in the late summer and fall.

**Feeding Habitat.** Because carpenter ants make up the bulk of the pileated woodpeck-er's diet, suitable ant habitat is selected for foraging by pileated woodpeckers. These ant colonies occur most often in large snags with advanced decay, the moist decaying butts of live trees, logs greater than 10 in. in diameter, and natural or cut stumps (Cline 1977, Conner et al. 1975, Bull 1980, Bull and Meslow 1977, McClelland 1977, 1979a). Furniss and Carolin (1977) noted that carpenter ants expecially favor fire-scarred and butt-rotted western redcedar trees, and will make extensive use of Douglas-fir, pines, and true firs.

In Montana, carpenter ants were found to select stands of high canopy cover, but ant densities declined as canopy cover increas-es past 90% (Youngs and Campbell n.d.). Similarly, stands with basal area in the range of 100 sq.ft. per acre were favored over more densely stocked stands (>150 sq.ft. per acre). *C.modoc* densities were positively correlated with dead wood volume in snags and stumps.

McClelland (1977) suggested that availability of food in winter may act as an ecological "bottleneck", limiting northern Rocky Moun-tain woodpecker populations. Snowpack makes logs and low stumps unavailable to feeding pileated woodpeckers.

McClelland (1979a) noted that pileated woodpeckers usually avoid open areas for feeding, preferring forests with a significant old-growth component and high basal area. Shelterwood cuts and small group selection cuts are suitable, but not preferred, feeding areas. Bull and Meslow (1977) classified preferred feeding habitats as having high densities of snags and logs, dense canopies, and tall ground cover, with more than 10% of the ground area covered by logs. Kilgore (1971) found that reduction of dead and down woody material by fire caused a decline in the use of a giant sequoia forest by pileateds for feeding.

In the northern Rockies, the density of snags and stumps at pileated feeding sites (not throughout the feeding range) averaged 7 per acre (Aney and McClelland 1985). At least 500 acres of suitable feeding habitat is needed within the home range of a pair (McClelland 1979a).

**Home Range Size.** Nesting pairs of pileated woodpeckers in the northern Rockies often cover 500-1000 ac. in their daily feeding activities (McClelland 1979a). In high-quality habitat in the northern Rockies, densities of 1 pair per 500 acres are not uncommon (McClelland pers. comm.). Bull (1987) estimated a density of one pair per 480 acres in northeastern Oregon, while Mellen (1987) reported an average home range size of 1200 acres for pairs in western Oregon.

**Dispersal Distance.**

Bull (1987) recorded juvenile dispersal distances of banded nestlings averaging 2 miles. The longest dispersal was 5.2 miles, although areas outside the study area were not searched, eliminating the chance of finding those that dispersed farther than 9.6 miles.

When adult birds lose their mates, they remain on territory. Juvenile dispersers are essential to mate with unpaired territorial adults and to recolonize unoccupied habitats (Bull pers. comm.).

## HABITAT SUITABILITY MODEL

Schroeder (1983) developed a pileated woodpecker habitat suitability index model for application across the range of the species. Aney and McClelland (1985) first developed this model, which is based on data from the northern Rocky Mountains.

Model outputs provide a relative rating of habitat quality which is useful for comparison purposes. Model predictions may not correspond with actual population numbers, since only habitat variables are considered.

### Applicability

***Geographic Area.*** This model applies to forested stands of the Columbian Highland Province of the northern Rocky Mountains, which includes west-central and northwestern Montana (west of the Continental Divide) and northern Idaho. In Montana, pileated woodpeckers are uncommon east of the Rocky Mountains, and are not known to nest in the extreme southern portions of the state.

***Season.*** Pileated woodpeckers are resident birds, and generally spend the entire year in the same area. This model considers the year round suitability of feeding stands, but concentrates on winter food sources as the limiting factor.

***Cover Types.*** This model applies to forested cover types in the northern Rockies.

***Minimum Area.*** A contiguous area of at least 100 acres of optimal habitat must be present before a stand can provide an opportunity for pileateds to nest. Feeding habitat must also be available within the 1000-acre home range surrounding the nesting core.

***Verification Level.*** This model is based on a review of published and unpublished research dealing with pileated woodpecker habitat associations in the western United States, with emphasis on research from the northern Rocky Mountains. Data collected by B.R. McClelland was used to develop the nesting habitat portion of this model; the feeding habitat portion is based on an analysis of data collected under the supervision of Mike Hillis, Lolo National Forest Wildlife Biologist. The model was revised based on initial testing by Karen Wilson on the Lolo National Forest; further modification and refinement is expected as the result of additional field verification.

### Model Variables

Nesting and feeding habitat suitability are treated separately in the model.

Nesting habitat suitability is a function of four variables: one reflecting stand conditions needed for nesting security (canopy cover), two describing the density of potential nest trees (dead or defective trees >20 inches dbh and >60 feet tall, and dead or defective trees >30 inches dbh and >60 feet tall), and one indicating the average size of potential nest sites (dbh). The number of potential nest sites is calculated separately for trees larger than 20 inches dbh and for trees larger than 30 inches dbh, since the size distribution of snags is usually skewed (K.Wilson pers. comm.). Suitable tree species are western larch, ponderosa pine, black cottonwood, and aspen.

Feeding habitat suitability is a function of canopy cover, density of potential winter feeding sites, and average diameter of potential winter feeding sites. Feeding sites include stumps, snags and butt-rotted trees of Douglas-fir, western larch, lodgepole pine, ponderosa pine, spruce, western redcedar, western hemlock, western white pine, black cottonwood, or aspen. Feeding trees must be greater than 10 inches in diameter. Feeding stumps must be taller that 3 feet in height and have a diameter greater than 12 inches.

## HABITAT EVALUATION

The value of habitat for pileated woodpecker can be calculated at two spatial scales: stand-level and home range-level.

**Stand-level Evaluation.** Individual stands can be evaluated as to their quality for nesting or feeding. Simple cubic root equations were originally chosen to represent the relationship between variables. However, in a test of Schroeder's (1983) model, Lancia and Adams (1985) found that an arithmetic mean would perform better becuase of sampling errors typically encountered when measuring snag densities.

Nesting Habitat Value = $[V(Ncc^1) + V(Npa^{20}) + V(Npa^{30}) + V(Ndbh)] / 4$
or $[V(Ncc^2) + V(Npa^{20}) + V(Npa^{30}) + V(Ndbh)] / 4$

Feeding Habitat Value = $[V(Fcc^1) + V(Fpa) + V(Fdbh)] / 3$
or $[V(Fcc^2) + V(Fpa) + V(Fdbh)] / 3$

| | | |
|---|---|---|
| *Where:* | $V(Ncc^1)$ = | Canopy cover in western larch nesting stands. |
| | $V(Ncc^2)$ = | Canopy cover in ponderosa pine and black cottonwood nesting stands. |
| | $V(Npa^{20})$ = | Number of potential nesting trees >20" dbh per acre. |
| | $V(Npa^{30})$ = | Number of potential nesting trees >30" dbh per acre. |
| | $V(Ndbh)$ = | Average DBH of potential nest trees larger than 20 inches dbh |
| | $V(Fcc^1)$ = | Canopy cover in feeding stands of western larch, lodgepole pine, western red cedar, spruce, and western white pine. |
| | $V(Fcc^2)$ = | Canopy cover in feeding stands of black cottonwood, ponderosa pine, and Douglas-fir. |
| | $V(Fpa)$ = | Number of potential feeding sites per acre. |
| | $V(Fdbh)$ = | Average diameter of potential feeding sites. |

Coefficients describing the relative value of each variable are displayed at the end of this section.

**Multiple Stand Evaluation.** An area of 500 to 1000 acres represents the home range of a pair. The home range should include 100 contiguous acres (one or more stands) of optimal habitat (nesting index value of 1.0). With suitable conditions (index value of 0.5), 200 acres of nesting habitat would be sufficient.

Once a suitable nest stand is identified, the next step is to evaluate the capability of surrounding stands to provide adequate feeding habitat for a resident pair of birds. An overall assessment of feeding habitat can be calculated as follows:

$$\text{Feeding Habitat-Acres} = \sum_{i=1}^{n} [\text{Acres } i * \text{Feeding Habitat Value } i].$$

Within the home range, at least 500 acres of suitable habitat (feeding index value of at least 0.5) is needed (McClelland 1979). Equivalent habitat could be provided on 250 acres of optimal feeding habitat (all acres having feeding habitat value of 1.0), 500 acres of suitable feeding habitat (stands with feeding habitat value averaging 0.5), or 1000 acres of marginal feeding habitat (stands with feeding habitat value averaging 0.25). Results of this calculation must be interpreted with care, since areas with uniform conditions of suboptimal habitat are indistinguishable from areas with a mix of optimal and unsuitable habitat, the latter being more desirable (Aney and McClelland 1985).

## SPATIAL ARRANGEMENT OF HABITAT

Large, contiguous habitat patches are more desirable than small, isolated patches. Often, old-growth habitats will be found along stream courses in linear patterns. To provide suitable pileated woodpecker habitat, strips should be at least 300 feet in width (McClelland 1979a).

Bull (1987) observed average dispersal distances by juveniles of about 2 miles. Suitable habitat areas should be spaced at 2 mile intervals, or at a density of one per 2,500 acres, to allow recolonization of unoccupied habitat by dispersing juveniles.

In fragmented landscapes, it is essential that high-quality breeding habitat be provided, in order to produce sufficient dispersers to maintain population distribution (Bull, pers. comm.).

## MODEL VARIABLES

**V(Ncc¹): Canopy cover in Western Larch Nesting Stands**

| Canopy Cover (%): | <30 | 30-49 | 50-65 | >65 |
|---|---|---|---|---|
| Value: | 0 | 0.4 | 0.8 | 1.0 |

**V(Ncc²): Canopy Cover in Ponderosa Pine, Aspen, and Black Cottonwood Nesting Stands**

| Canopy Cover (%) : | 15 | 15-30 | >30 |
|---|---|---|---|
| Value : | 0.0 | 0.5 | 1.0 |

**V(Npa²⁰): Number of Potential Nest Trees Per Acre >20" dbh** *(Dead or live defective)*

| No. per Acre: | <0.5 | 0.5-2.0 | 2.1-4.0 | 4.1-7.0 | >7.0 |
|---|---|---|---|---|---|
| Value: | 0.0 | 0.1 | 0.4 | 0.8 | 1.0 |

**V(Npa³⁰): Number of Potential Nest Trees Per Acre >30" dbh** *(Dead or live defective)*

| No. per Acre: | <0.5 | 0.5-1.0 | 1.1-3.0 | >3.0 |
|---|---|---|---|---|
| Value: | 0.0 | 0.3 | 0.7 | 1.0 |

**V(Ndbh): Average size (dbh) of Potential Nest Trees** *(Dead or live defective tree greater than 20 inches dbh)*

| Diameter (inches): | <20 | 20-25 | 26-30 | >30 |
|---|---|---|---|---|
| Value: | 0.0 | 0.3 | 0.7 | 1.0 |

**V(Fcc[1]): Canopy Cover in Feeding Stands of Western Larch, Lodgepole Pine, Western Redcedar, Grand Fir, Spruce, and Western White Pine**

| Canopy Cover (%): | <30 | 30-49 | 50-85 | >85 |
|---|---|---|---|---|
| Value: | 0.0 | 0.5 | 1.0 | 0.8 |

**V(Fcc[2]): Canopy Cover in Feeding Stands of Ponderosa Pine, Douglas-fir, Black Cottonwood, and Aspen**

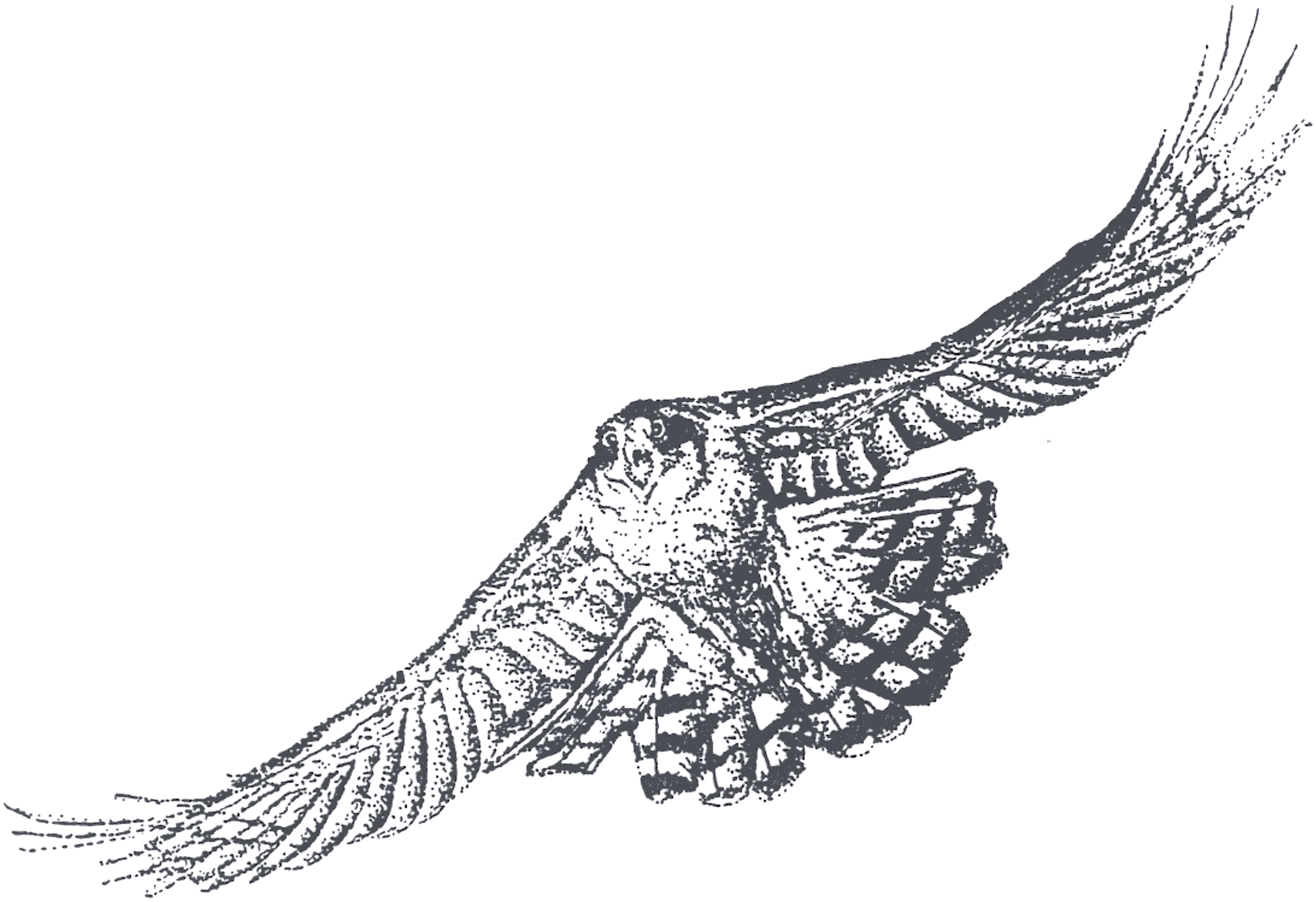
| Canopy Cover (%): | <15 | 15-30 | 30-85 | >85 |
|---|---|---|---|---|
| Value: | 0.0 | 0.5 | 1.0 | 0.8 |

**V(Fpa): Number of Potential Feeding Sites per Acre** *(Live with butt-rot or dead tree greater than 10 inches dbh, or stumps greater than 3 ft. tall and at least 12 inches in diameter. Suitable species are Douglas-fir, Western Larch, Ponderosa Pine, Lodgepole Pine, Western Redcedar, Western Hemlock, Western White Pine, Spruce, Black Cottonwood, and Aspen.*

| No. Per Acre: | <1.0 | 1.0 - 2.5 | 2.5 - 7.0 | >7.0 |
|---|---|---|---|---|
| Value: | 0.0 | 0.3 | 0.7 | 1.0 |

**V(Fdbh): Average size of Potential Feeding Sites** (*see definitions above*)

| Diameter (inches): | <10 | 10-15 | 16-20 | >20 |
|---|---|---|---|---|
| Value | 0.0 | 0.3 | 0.7 | 1.0 |



Amy Hetrick Jacobs 9/90